PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference AA 1599 PCT	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB 03/04006	International filing date *(day/month/year)* 15.09.2003	Priority date *(day/month/year)* 13.09.2002
International Patent Classification (IPC) or both national classification and IPC F02B1/12		
Applicant JOHNSON MATTHEY PUBLIC LIMITED COMPANY		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
30.03.2004	22.11.2004
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Sideris, M Telephone No. +31 70 340-3406

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB 03/04006

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-17 as originally filed

Claims, Numbers

1-46 filed with telefax on 13.07.2004

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-46
	No:	Claims	
Inventive step (IS)	Yes:	Claims	2-4,10-12,24-27,31-35,40-42
	No:	Claims	1,5-9,13-23,28-30,36-39,43-46
Industrial applicability (IA)	Yes:	Claims	1-46
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following document:
D1: WO 00 28196 (Ceryx Incorporated)

2. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1 and 9 does not involve an inventive step in the sense of Article 33(3) PCT.

The document D1 is regarded as being the closest prior art to the subject-matter of claims 1 and 9, and discloses (the references in parentheses applying to this document):

A process and a device for treating exhaust gas from a compression ignition (Diesel) engine, wherein substantially all fuel for combustion is injected into a combustion chamber prior to start of combustion (homogenous charge compression ignition - see page 3, lines 17-26), which process comprising contacting the exhaust gas with a catalyst (22) comprising a supported palladium (Pd) catalyst (see page 4, lines 13-16; fig. 1).

The subject-matter of claim 1 therefore differs from this known process and device in that: at least one base metal promoter is supported on the surface of a catalyst.

The problem to be solved by the present invention may therefore be regarded as to improve the oxidation properties of the catalyst.

The solution proposed in claims 1 and 9 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons.

The feature "...one base metal promoter", especially the use of CeO_2, is merely one of several straightforward possibilities from which the skilled person would select during the construction of a catalyst, in accordance with circumstances, without the exercise of inventive skill, in order to solve the problem posed.

3. Dependent claims 5-8, 13-23, 28-30, 36-39 and 43-46 do not contain any features

which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, see document D1 (page 3, line 17 - page 5, line 12; figures).

4. The combination of the features of dependent claims 2-4, 10-12, 24-27, 31-35 and 40-42 is neither known from, nor rendered obvious by, the available prior art.

5, The document D1 is not cited and briefly discussed in the introduction of the description (Rule 5.1(a)(ii) PCT).

CLAIMS:

1. A process for treating exhaust gas from a compression ignition engine, wherein substantially all fuel for combustion is injected into a combustion chamber prior to the start of combustion, which process comprising contacting the exhaust gas with a catalyst comprising a supported palladium (Pd) catalyst.

2. A process according to claim 1, wherein the catalyst comprises at least one base metal promoter.

3. A process according to claim 1 or 2, wherein the exhaust gas comprises >2000ppm carbon monoxide (CO).

4. A process according to claim 1, 2 or 3, wherein the exhaust gas comprises >500ppm C_1 unburned hydrocarbons (HCs).

5. A process according to claim 1, 2, 3 or 4, wherein the exhaust gas temperature is below 250°C.

6. A process according to any of claims 1 to 5, wherein the catalyst comprises platinum (Pt).

7. A process according to claim 6, wherein the catalyst is arranged so that the exhaust gas contacts the Pd and then contacts the Pt.

8. A process according to claim 6 or 7, wherein combustion of CO in the exhaust gas over the Pd creates an exotherm to heat the Pt, thereby promoting reactions of the exhaust gas components catalysed by the Pt.

9. A process according to claim 8, wherein reactions catalysed by Pt include HC oxidation and combustion of particulate matter.

10. A compression ignition engine wherein substantially all fuel for combustion is injected into a combustion chamber prior to the start of combustion, which engine comprising an exhaust system comprising a supported palladium (Pd) catalyst.

11. An engine according to claim 10, wherein the catalyst comprises at least one base metal promoter.

12. An engine according to claim 10 or 11 producing exhaust gas comprising >2000ppm carbon monoxide (CO).

13. An engine according to claim 10, 11 or 12, producing exhaust gas comprising >500ppm C_1 unburned hydrocarbons (HC).

14. An engine according to claim 10, 11, 12 or 13, producing exhaust gas of below 250°C in temperature.

15. An engine according to any of claims 10 to 14, wherein the at least one base metal promoter is a reducible oxide or a basic metal or any mixture of any two or more thereof.

16. An engine according to claim 15, wherein the at least one reducible oxide is an oxide of manganese, iron, cobalt, copper, tin or cerium.

17. An engine according to claim 16, wherein the at least one reducible oxide is at least one of MnO_2, Mn_2O_3, Fe_2O_3, CuO, CoO, SnO_2 and CeO_2.

18. An engine according to claim 15, 16 or 17, wherein the reducible oxide is dispersed on the support.

19. An engine according to claim 15, 16 or 17, wherein the support *per se* comprises particulate bulk reducible oxide.

20. An engine according to claim 15, wherein the at least one basic metal is an alkali metal, an alkaline earth metal or a lanthanide metal or any mixture, compound oxide or mixed oxide of any two or more thereof.

21. An engine according to claim 20, wherein the at least one alkaline earth metal is barium, magnesium, calcium, strontium.

22. An engine according to claim 20, wherein the at least one alkali metal is sodium, potassium or caesium.

23. An engine according to claim 20, wherein the at least one lanthanide metal is cerium or lanthanum.

24. An engine according to any of claims 10 to 23, wherein the catalyst comprises platinum (Pt), optionally supported Pt.

25. An engine according to claim 24, wherein the Pd and Pt are on the same support.

26. An engine according to claim 24, wherein the supported Pd and the at least one base metal promoter are disposed on a first substrate and the Pt is disposed on a second substrate, which second substrate is disposed downstream of the first substrate.

27. An engine according to claim 24, wherein the supported Pd and the at least one base metal promoter are disposed on an upstream part of a substrate and the Pt is disposed on a downstream part thereof.

28. An engine according to claim 24, wherein the Pt is disposed in a first layer on a substrate and the supported Pd and the at least one base metal promoter are disposed in a second layer overlying the first layer.

29. An engine according to claim 24, wherein a first support comprises of the supported Pd and the at least one base metal promoter and the Pt is carried on a second particulate support, wherein the first and second supports are disposed on a substrate in a single layer.

30. An engine according to any of claims 10 to 29, wherein the Pd support and, where present, the Pt support comprises at least one of alumina, silica-alumina, ceria, magnesia, titania, zirconia, a zeolite or a mixture, composite oxide or mixed oxide of any two or more thereof.

31. An engine according to claim 30, wherein the support comprises at least one basic metal.

32. An engine according to claim 31, wherein the at least one basic metal comprises at least one of zirconium, cerium, lanthanum, alumina, yttrium, praseodymium, barium and neodymium.

33. An engine according to any of claims 30, 31 or 32, wherein the support comprises lanthanum-stabilised alumina.

34. An engine according to claim 30, 31 or 32, wherein the support comprises ceria and zirconia, optionally in a weight ratio of from 5:95 to 95:5.

35. An engine according to any of claims 10 to 34, wherein the catalyst contains from 0.1 to 30%, optionally from 0.5-15% and preferably 1-5% by weight of PGM based on the total weight of the catalyst.

36. An engine according to claim 35, wherein the catalyst contains a weight ratio of from 100:0 to 10:90 Pd:Pt.

37. An engine according to claim 35 or 36, wherein the catalyst contains from 0.1 to 10% Pt by weight based on the total weight of the catalyst and from 0.1 to 20% by weight based on the total weight of the catalyst.

38. An engine according to any of claims 10 to 37, having a first running condition wherein the engine is configured to run during at least one portion of an engine cycle in a mode wherein substantially all fuel for combustion is injected into a combustion chamber

prior to the start of combustion, and a second condition wherein the engine is configured to run in a conventional direct injection diesel engine mode.

39. An engine according to claim 38, wherein the engine switches to the second condition during high engine load.

40. An engine according to any of claims 10 to 39, comprising control means, in use, for controlling a fuel combustion mode of the engine.

41. An engine according to claim 40, wherein the control means comprises a pre-programmed processor and optionally forms part of the engine control unit (ECU).

42. An engine according to claim 41, wherein the exhaust system comprises an optionally catalysed particulate filter disposed downstream of the supported Pd catalyst.

43. An engine according to claim 41 or 42, including an exhaust gas recirculation valve and circuit to recirculate a selected portion of the exhaust gas to the engine air intake.

44. An engine according to claim 43, wherein the recirculated exhaust gas is cooled prior to mixing with the engine intake air.

45. A diesel engine according to any of claims 10 to 44.

46. A diesel engine according to claim 45, wherein it is a homogeneous charge compression ignition (HCCI) diesel engine or a Dilution Controlled Combustion System (DCCS) diesel engine.

47. A vehicle including an engine according to any of claims 10 to 46.

48. A light duty diesel vehicle according to claim 47.

INTERNATIONAL SEARCH REPORT

Interna[redacted] Application No
PCT/GB 03/04006

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02B1/12 F01N3/28 F01N3/035

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02B F01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 28196 A (CERYX INC ;EDGAR BRADLEY L (US); PAGE DORRIAH L (US); MACDONALD RO) 18 May 2000 (2000-05-18)	1,6-10, 30, 38-41, 45-48
Y	page 2, line 6 - line 14 page 3, line 15 -page 5, line 2; figures	2,11, 15-18, 20-25, 30-33
Y	EP 0 786 284 A (FORD MOTOR CO) 30 July 1997 (1997-07-30) column 3, line 41 -column 5, line 15	2,11, 15-18, 20-25, 30-33

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 January 2004	14/01/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Sideris, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB 03/04006

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 05, 31 May 1996 (1996-05-31) & JP 08 014029 A (TOYOTA MOTOR CORP), 16 January 1996 (1996-01-16) abstract	24,26,27
A	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 06, 4 June 2002 (2002-06-04) & JP 2002 045702 A (CATALER CORP), 12 February 2002 (2002-02-12) abstract	
A	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 09, 4 September 2002 (2002-09-04) & JP 2002 129937 A (NISSAN DIESEL MOTOR CO LTD), 9 May 2002 (2002-05-09) abstract	
A	EP 0 341 832 A (JOHNSON MATTHEY INC) 15 November 1989 (1989-11-15) cited in the application	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 03/04006

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